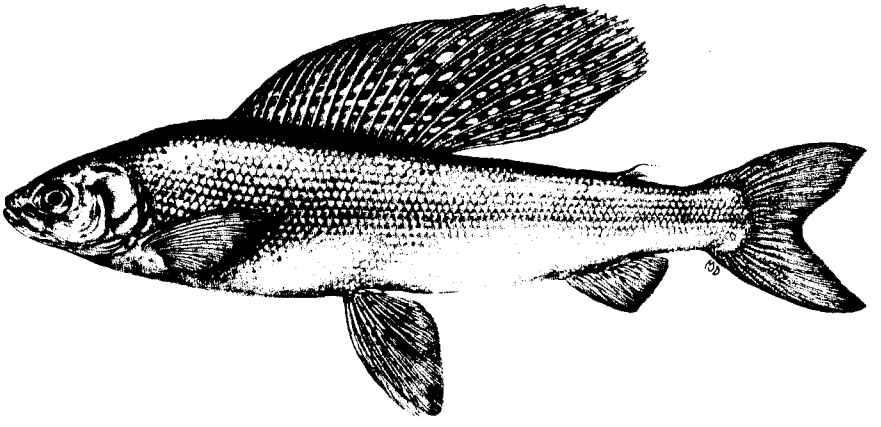
FISH USE OF FAIRBANKS CREEK IN RELATION TO PAST AND PRESENT MINING

By

Alvin G. Ott and Alan H. Townsend

Technical Report No. 96-6



Alaska Department of Fish and Game
P.O. Box 25526
Juneau, Alaska 99802-5526

July 1996

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Director
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ACKNOWLEDGMENTS

We thank Mr. Cook (miner) for his cooperation with us during the diversion of Fairbanks Creek. Our thanks to Ms. Pat Franklin for providing input on the historical mining in Fairbanks Creek. We also thank Ms. Sheree Warner, Alaska Department of Fish and Game (ADF&G) for preparing figures, Mr. Carl Hemming (ADF&G) and Mr. Carl Lunderstadt (ADF&G) for assisting with field data collection, and Mr. Jack Winters (ADF&G) for providing constructive editing of the report.

EXECUTIVE SUMMARY

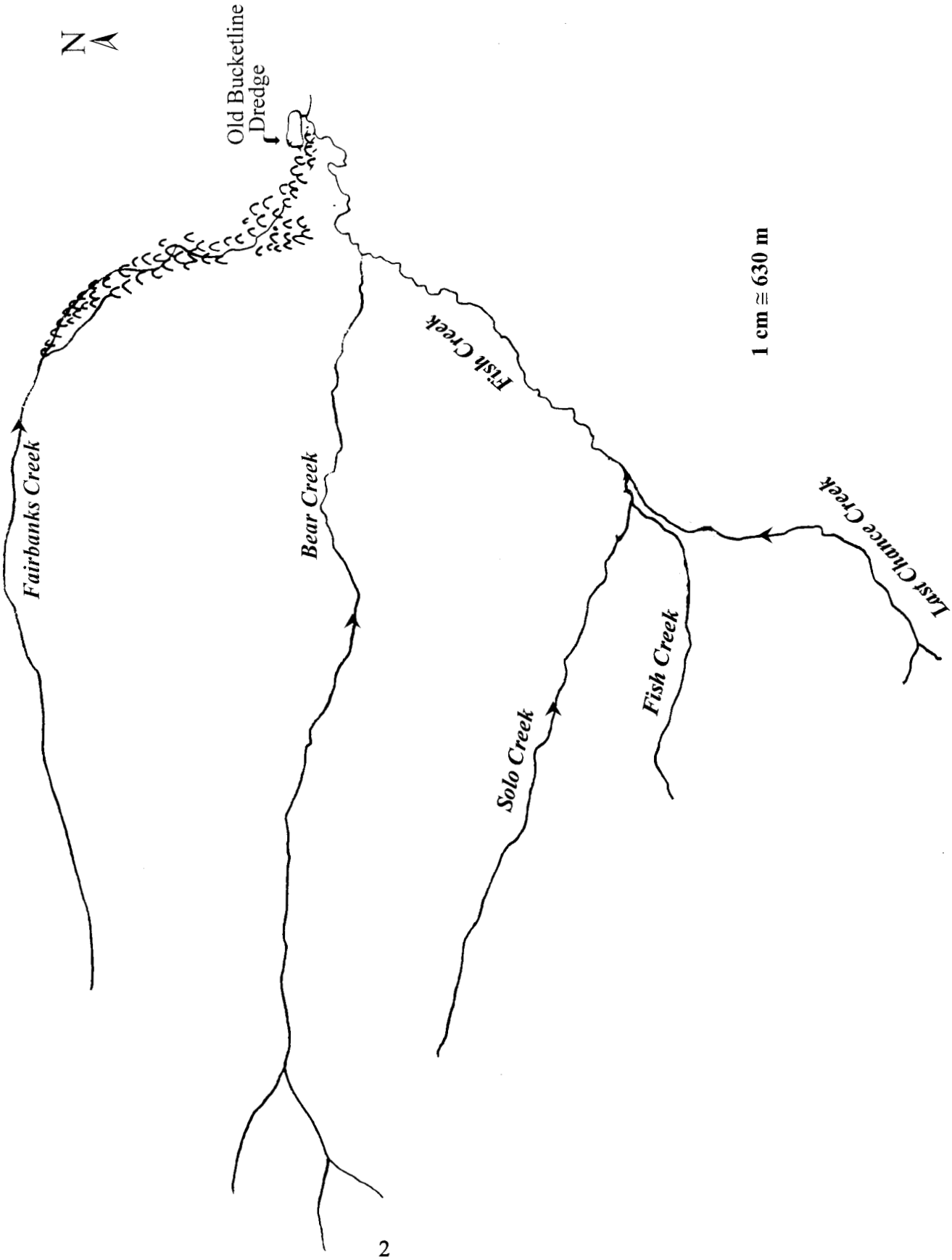
Fairbanks Creek has been mined extensively since the early 1900s. Bucket line dredging created a tailing dam in Fairbanks Creek near its confluence with Deep Creek sometime after 1950. Only Arctic grayling (*Thymallus arcticus*) remain in Fairbanks Creek upstream of the tailing barrier. A permanent diversion of Fairbanks Creek to facilitate placer mining was permitted and fish use of the original channel was determined prior to diversion. About 50% of the fish left the abandoned channel following diversion and most of remaining fish were caught and moved to the newly constructed channel. The new channel will be monitored in the future to assess fish use.

INTRODUCTION

Fairbanks Creek is located about 32 km (20 mi) northeast of Fairbanks (Figure 1). The creek flows in a southeast direction to Fish Creek in the upper Little Chena River drainage. Two dredges operated in the middle part of Fairbanks Creek in the 1920s. The Fairbanks Exploration (FE) Company moved Dredge No. 2 to Fairbanks Creek in 1949, and probably started mining in 1950 (Franklin 1996). Dredge No. 2 left the tailing dam below Deep Creek and that dredge shut down in about 1962 (Franklin 1996). The entire flow of Fairbanks Creek is subsurface through tailing for about 3.2 km (2 mi). The upper portion of Fairbanks Creek and tributaries have been placer mined. Franklin's placer mining operation was on Fairbanks, Alder, and Walnut Creeks from 1939 to 1958 (Franklin 1996). Ms. Franklin recalls observing Arctic grayling off and on in Fairbanks Creek during the years they mined. Virtually the entire drainage has been physically altered by mining over the past 80 years.

Fairbanks Creek, upstream from its confluence with Deep Creek, probably has been physically isolated (i.e., no surface flow connection) from Fish Creek in the Little Chena River drainage since the mid-1950s. Information from local miners and visual observations made during placer mine field inspections indicated that fish were present in Fairbanks Creek upstream of the tailing block. We began a small-scale fish sampling program in 1993 to determine fish species presence and abundance, and to collect data on fish movement above and below a road crossing. In 1994, sampling continued, and in 1995, additional work was done to evaluate a permanent stream diversion proposed by Mr. John Cook. The stream diversion was done to move surface water away from a series of mine cuts along the west side of the valley, thus reducing ground water flow into the active mine area. Our sampling program in 1995 was designed to

Figure 1. Fairbanks Creek located northeast of Fairbanks in the upper Little Chena River drainage.



determine fish use of the original channel prior to diversion. Fish sampling also was done post-diversion in the dewatered channel to assess fish entrapment. Sampling in the constructed channel will be conducted in 1996 to determine fish use in comparison with use of the original channel. This report presents findings regarding fish use of Fairbanks Creek, movements of fish among sample reaches, and fish use and entrapment in the reach of Fairbanks Creek diverted in summer 1995.

METHODS

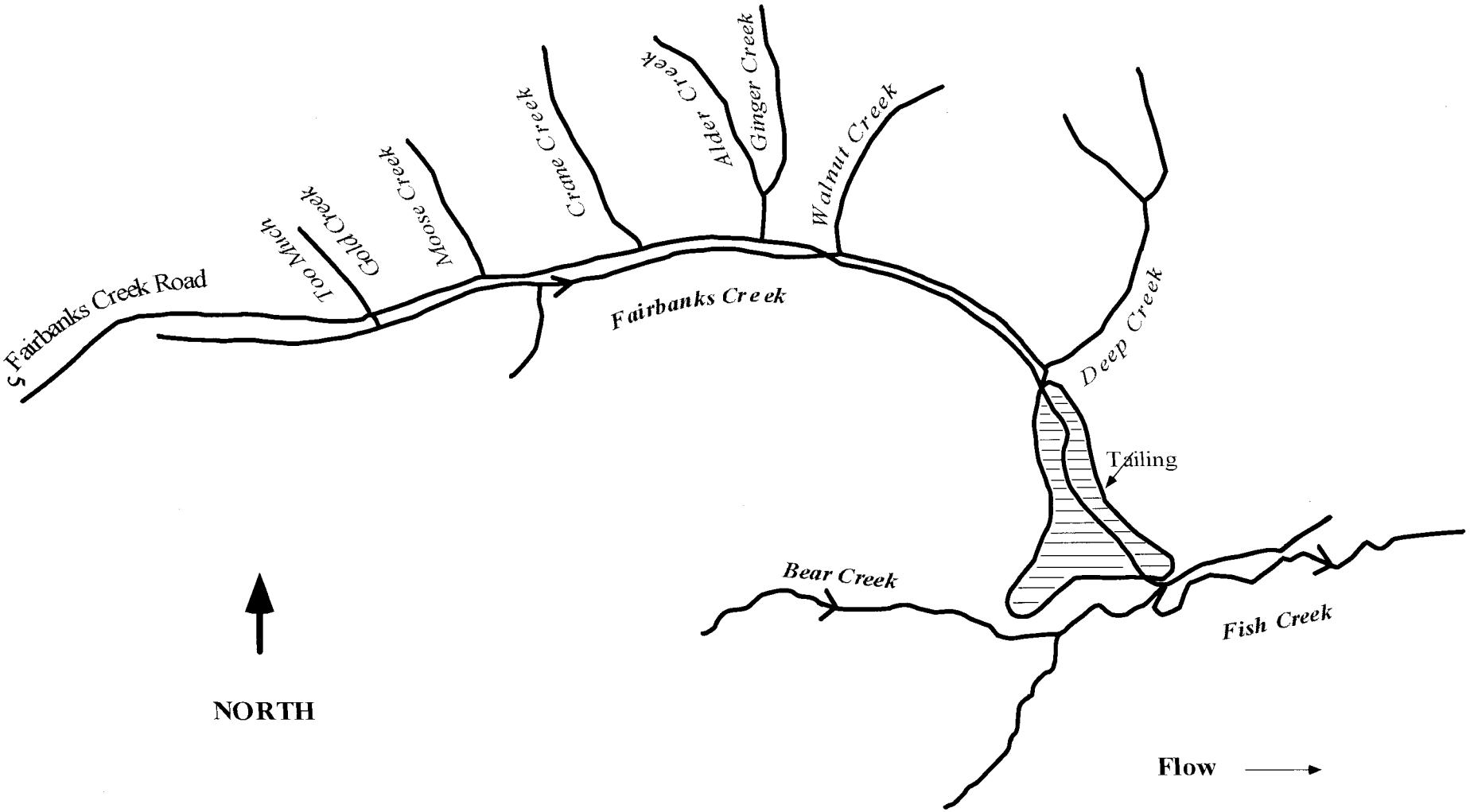
In 1993, we established sample sites in Fairbanks Creek to determine fish species present, to estimate fish numbers, and to determine fish movements among sample reaches. Reaches were fished upstream and downstream from a culverted crossing of Fairbanks Creek located immediately upstream of Walnut Creek (Figure 2). The culvert is perched about 15 cm (6 in) with a large downstream scour pool. Upstream movement of fish through the culvert probably is obstructed under high stream discharges and upstream movement of small fish probably is limited under all flow conditions. The location and length of each sample reach is presented in Table 1. The linear feet of stream worked in the Deep Creek sample reach varied due to changes in the location and length of the proposed diversion.

Table 1. Location and length of sample reaches in Fairbanks Creek.

Year	Sample Reach	Length (m)	Location
1993	Deep Creek	275 m	Deep Creek Upstream
1993	Walnut Creek	320 m	Walnut Creek Downstream
1993	Alder Creek	183 m	Upstream-Downstream from Alder Creek
1993	Crane Creek	762 m	Upstream-Downstream from Crane Creek
1993	Moose Creek	30 m	Moose Creek Below Road
1994	Deep Creek	30 m	Deep Creek Upstream
1995	Deep Creek	970 m	Deep Creek Upstream
1995	Deep Creek	560 m	Deep Creek Upstream[1]

[1]The 560 m reach was the actual portion of Fairbanks Creek planned for a permanent stream diversion.

Figure 2. Location of sample areas in Fairbanks Creek.



In 1995, we took photographs of the original channel and the proposed diversion prior to and after construction. We also measured the length of the original and permanent stream diversion channels. The diversion plan developed by Mr. Cook (miner), Mr. Zufelt of the Bureau of Land Management, and Mr. Townsend (ADF&G) entailed creating a permanent diversion channel of comparable length, a gradient of less than 2%, and a 4.4 m (14 to 15 ft) wide channel bottom. Areas for stream flooding and meanders were retained where possible. About 25% of the permanent diversion was constructed through old tailing.

We collected fish with a Smith-Root model 15-A backpack electrofisher using a single pass beginning at the downstream end of the sample reach. Some Arctic grayling >150 mm fork length (FL) were marked with *Fine Fabric Floy-tags* and some fish <150 mm FL were marked with an adipose fin clip. We collected fish with a hand-held dip net, placed them in a plastic bucket, and after measuring and marking, released the fish below the next area to be fished.

RESULTS AND DISCUSSION

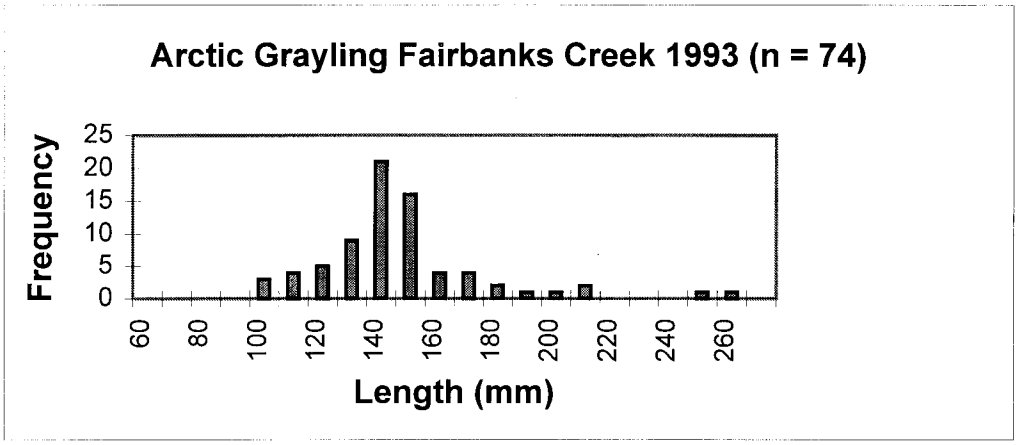
In 1993, we found only Arctic grayling in Fairbanks Creek. Sampling in 1994 and 1995 confirmed that the only fish species present in Fairbanks Creek was Arctic grayling. Common fish species expected to be present include burbot (*Lota lota*), slimy sculpin (*Cottus cognatus*), Arctic grayling, longnose sucker (*Catostomus catostomus*), and round whitefish (*Prosopium cylindraceum*). All these species occur in Fish Creek at the confluence of Fish and Fairbanks Creeks and all species, except longnose sucker, occur in Bear Creek, a tributary to Fish Creek about 3.2 km (2 mi) upstream of Fairbanks Creek. We believe, but cannot prove, that prior to mining in Fairbanks Creek, burbot, slimy sculpin, Arctic grayling, and round whitefish were present. Thus, the short-term and long-term effects of mining, including the permanent blockage created by tailing in the lower 4 km (2.5 mi) of Fairbanks Creek, resulted in the survival of only Arctic grayling.

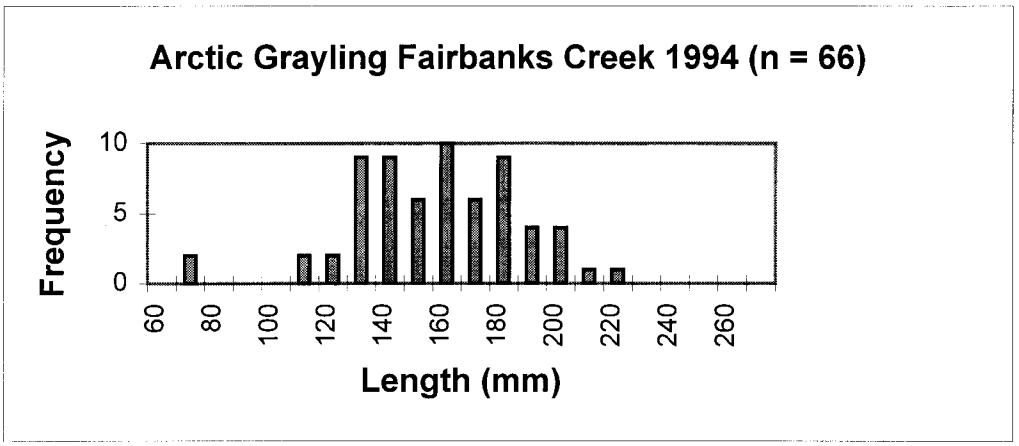
In previous investigations we sampled fish above and below the Faith Creek Dam in the Chatanika River near Steese Highway Milepost 68. While Fairbanks Creek contains about 8 km (5 mi) of accessible fish habitat upstream of the tailing barrier, the Chatanika River has about 112 km (70 mi) of fish habitat above the Faith Creek Dam. The Faith Creek Dam was built between 1925 and 1928 to divert water into the Davidson Ditch. The Faith Creek Dam blocks upstream movement of all fish. Fish species present in the Chatanika River immediately downstream of the dam include chinook salmon (*Onchorhynchus tshawytscha*) juveniles, slimy sculpin, burbot, round whitefish, Arctic grayling, and longnose suckers. We sampled streams (e.g., Faith Creek, McManus Creek, Hope Creek) upstream of the Faith Creek Dam in the early 1990s, and caught only slimy sculpin and Arctic grayling. While extensive mining has

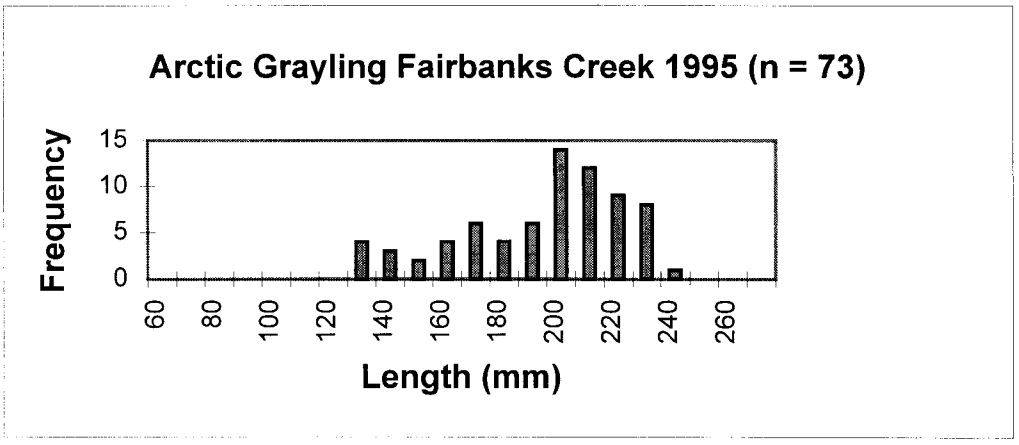
occurred in Faith Creek, minimal mining has taken place in McManus, Smith, and Pool Creeks. Both Arctic grayling and slimy sculpin survived in the upper Chatanika River drainage upstream of the dam whereas longnose suckers, burbot, round whitefish, and chinook salmon did not. We conclude that survival of burbot, chinook salmon, round whitefish, and longnose suckers appears to require free movement upstream and downstream to access suitable spawning or overwintering habitat since it appears that the upper reaches of these creeks provide rearing habitat for these species. Slimy sculpin survived upstream of the Faith Creek Dam because all portions of the drainage were not mined and habitats for successful spawning and overwintering were present.

We tagged Arctic grayling in 1993, 1994, and 1995 in Fairbanks Creek (Appendix 1). The number of recaptures to date is low but resampling has been limited. Based on recaptures to date, there has been little movement among sample areas and fish have not mixed among sample stretches above and below the Fairbanks Creek culvert crossing. In 1993 and 1994 we tagged 53 Arctic grayling in the Deep Creek reach, recaptured 12 of them in the same area in 1995 (Appendix 1). Lack of movement by Arctic grayling among sample reaches also was found in upper Fish Creek where we collected fish from Last Chance, Bear, and Fish Creeks (Ott et al. 1995). Length frequency data were obtained for the Deep Creek sample reach in 1993, 1994, and 1995 (Figure 3). Lack of recruitment by young-of-the-year fish was apparent in all sample years. This pattern of poor recruitment also was observed in our work in upper Fish Creek where the only successful spawning and fry rearing was found in outlets from settling ponds (Ott et al. 1995). Poor recruitment was attributed to high stream flows shortly after spawning in spring.

Figure 3. Length frequency of Arctic grayling collected in Fairbanks Creek (Deep Creek sample reach) in 1993, 1994, and 1995.







The original stream channel in the area of the proposed diversion was 560 m (1836 ft) long. On July 6, 1995, we collected 73 Arctic grayling from this reach of Fairbanks Creek (Appendix 1). On July 24, 1995, we resampled the same stretch of creek and collected 89 fish. Our population estimate (Chapman 1951) for Arctic grayling >150 mm is 123 with a 95% CI of 108 to 138 fish. Numbers of fish less than 150 mm, excluding young-of-the-year, were small with only 13 caught on July 6 and 11 on July 24.

A Fish Habitat Permit was issued to Mr. Cook to divert Fairbanks Creek from its original channel following our July sampling events (Figure 4). Field inspections were conducted to stake the proposed location of the new channel (Figures 4 and 5) and a plan for how the diversion would be done was developed (Zufelt 1995). The diversion was constructed during July but was not connected as plugs were retained at both the upstream and downstream end. After the constructed channel was built (Figure 4), the site was inspected and some minor modifications were made (Zufelt 1995). The newly-built channel is about 457 m (1500 ft) long with a slight gradient (1%) and is relatively straight. The channel is restricted along the upper and lower ends by tailing but most of the channel has about 15 to 18 m (50 to 60 ft) of floodplain available for high water events. Most of the channel substrate is cobble and gravel, with a short reach containing fine material. The diversion channel was completed in mid-July and then flooded in late July. First, the downstream plug was excavated and then the upstream plug was removed partially to allow water to begin to flow. Within several days, the remainder of the upstream plug was removed and the original channel was blocked with a gravel fill. Flow reductions were expected to induce fish to move out of the original channel before it was blocked at both ends. However, extensive ground water

Figure 4. The original channel of Fairbanks Creek prior to diversion (top photo) and the proposed location of the permanent channel (bottom photo).

Figure 5. The proposed route of the permanent diversion channel through tailing (top photo) and the constructed permanent channel prior to diversion of water (bottom photo).

flow continued to feed the original channel. On August 9, 1995, Mr. Cook notified us that fish were still present in the original channel which was now isolated by gravel plugs. We electrofished the channel, collected 48 Arctic grayling and moved these fish to the new channel. On October 13, 1995, we again fished the isolated channel and collected 16 more age 1+ and 96 young-of-the-year Arctic grayling. We moved all fish to the new channel of Fairbanks Creek.

Assuming the population estimate of 123 fish >150 mm FL was accurate, about 50% of the Arctic grayling left the original channel as planned. It also was quite apparent that at least 96 young-of-the-year and 64 age 1+ fish would have been lost if Mr. Cook had not contacted us and requested that we electrofish the abandoned channel to capture and move fish. Mr. Cook's observations support the need for multiple sampling periods following a stream diversion as all fish are not captured during a single event.

Many placer operations include a stream bypass to route water around the active mine area. In some cases, the diversions are permanent and in others they are temporary. Data on fish entrapment, fish use, and recolonization of newly-constructed channels are limited. We plan to monitor the newly-built Fairbanks Creek channel to determine fish use and habitat changes over the next several years.

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Zufelt, W.J. 1995. New channel construction on Fairbanks Creek. Memorandum dated July 26, 1995. Bureau of Land Management. 3 pp.

Appendix 1. Arctic grayling caught and released in Fairbanks Creek in 1993, 1994, and 1995.

Tag Number	Color	Length (mm)	Date Captured	Site Captured	Recapture Date	Recapture Site	Length (mm)
		146	5/20/93	Deep Creek			
		142	5/20/93	Deep Creek			
		133	5/20/93	Deep Creek			
3905	Y	173	5/20/93	Deep Creek			
		142	5/20/93	Deep Creek			
		141	5/20/93	Deep Creek			
3904	Y	165	5/20/93	Deep Creek	6/7/95	Deep Creek	207
		140	5/20/93	Deep Creek			
		138	5/20/93	Deep Creek			
		116	5/20/93	Deep Creek			
		122	5/20/93	Deep Creek			
		135	5/20/93	Deep Creek			
		128	5/20/93	Deep Creek			
		117	5/20/93	Deep Creek			
3903	Y	201	5/20/93	Deep Creek	7/24/95	Deep Creek	260
		128	5/20/93	Deep Creek			
3902	Y	182	5/20/93	Deep Creek			
		126	5/20/93	Deep Creek			
		136	5/20/93	Deep Creek			
		123	5/20/93	Deep Creek			
		145	5/20/93	Deep Creek			
		134	5/20/93	Deep Creek			
		137	5/20/93	Deep Creek			
		101	5/20/93	Deep Creek			
3901	Y	152	5/20/93	Deep Creek			
774	Y	166	5/20/93	Deep Creek	6/8/93	Deep Creek	166
					6/7/95	Deep Creek	205
		139	5/20/93	Deep Creek			
775	Y	165	5/20/93	Deep Creek	6/8/93	Deep Creek	163
					6/7/95	Deep Creek	199
					7/6/95	Deep Creek	209
		137	5/20/93	Deep Creek			
		142	5/20/93	Deep Creek			
		140	5/20/93	Deep Creek			
		145	5/20/93	Deep Creek			
		137	5/20/93	Deep Creek			
		144	5/20/93	Deep Creek			
		138	5/20/93	Deep Creek			
		127	5/20/93	Deep Creek			
		139	5/20/93	Deep Creek			
		136	5/20/93	Deep Creek			
		131	5/20/93	Deep Creek			
773	Y	150	5/20/93	Deep Creek	6/8/93	Deep Creek	152
		95	5/20/93	Deep Creek			
		107	5/20/93	Deep Creek			
		100	5/20/93	Deep Creek			

Appendix 1. Continued.

Tag Number	Color	Length (mm)	Date Captured	Site Captured	Recapture Date	Recapture Site	Length (mm)
		94	5/20/93	Deep Creek			
		122	5/20/93	Deep Creek			
771	Y	252	5/20/93	Deep Creek	6/8/93	Deep Creek	250
770	Y	242	5/20/93	Deep Creek			
769	Y	202	5/20/93	Deep Creek	6/8/93	Deep Creek	199
					6/7/95	Deep Creek	235
					7/6/95	Deep Creek	235
768	Y	191	5/20/93	Deep Creek			
767	Y	170	5/20/93	Deep Creek	6/8/93	Deep Creek	172
766	Y	179	5/20/93	Deep Creek	6/7/95	Deep Creek	219
		132	5/20/93	Deep Creek			
		140	5/20/93	Deep Creek			
		148	5/20/93	Deep Creek			
765	Y	156	5/20/93	Deep Creek	6/8/93	Deep Creek	159
					7/6/95	Deep Creek	218
764	Y	155	5/20/93	Deep Creek	7/6/95	Deep Creek	212
		143	5/20/93	Deep Creek			
		158	5/20/93	Deep Creek			
		144	5/20/93	Deep Creek			
		149	5/20/93	Deep Creek			
		145	5/20/93	Deep Creek			
		134	5/20/93	Deep Creek			
		141	5/20/93	Deep Creek			
		135	5/20/93	Deep Creek			
		140	5/20/93	Deep Creek			
		130	5/20/93	Deep Creek			
763	Y	150	5/20/93	Deep Creek	6/8/93	Deep Creek	147
					6/8/95	Deep Creek	200
					7/6/95	Deep Creek	210
		129	5/20/93	Deep Creek			
		135	5/20/93	Deep Creek			
		107	5/20/93	Deep Creek			
		117	5/20/93	Deep Creek			
		114	5/20/93	Deep Creek			
		111	5/20/93	Deep Creek			
		109	5/20/93	Deep Creek			
252	W	172	5/17/94	Deep Creek			
253	W	152	5/17/94	Deep Creek			
254	W	168	5/17/94	Deep Creek			
255	W	152	5/17/94	Deep Creek			
		136	5/17/94	Deep Creek			
256	W	199	5/17/94	Deep Creek			
		142	5/17/94	Deep Creek			
257	W	217	5/17/94	Deep Creek			
258	W	177	5/17/94	Deep Creek			

Appendix 1. Continued.

Tag Number	Color	Length (mm)	Date Captured	Site Captured	Recapture Date	Recapture Site	Length (mm)
259	W	190	5/17/94	Deep Creek			
260	W	186	5/17/94	Deep Creek			
261	W	169	5/17/94	Deep Creek			
262	W	165	5/17/94	Deep Creek			
263	W	210	5/17/94	Deep Creek	6/7/95	Deep Creek	238
		140	5/17/94	Deep Creek			
264	W	175	5/17/94	Deep Creek			
265	W	155	5/17/94	Deep Creek			
266	W	168	5/17/94	Deep Creek	6/7/95	Deep Creek	178
		146	5/17/94	Deep Creek			
267	W	195	5/17/94	Deep Creek			
268	W	171	5/17/94	Deep Creek			
		66	5/17/94	Deep Creek			
		125	5/17/94	Deep Creek			
		124	5/17/94	Deep Creek			
		131	5/17/94	Deep Creek			
269	W	175	5/17/94	Deep Creek			
270	W	195	5/17/94	Deep Creek			
271	W	185	5/17/94	Deep Creek			
272	W	177	5/17/94	Deep Creek	6/7/95	Deep Creek	204
273	W	164	5/17/94	Deep Creek			
274	W	177	5/17/94	Deep Creek			
		124	5/17/94	Deep Creek			
275	W	197	5/17/94	Deep Creek			
276	W	176	5/17/94	Deep Creek			
		121	5/17/94	Deep Creek			
277	W	172	5/17/94	Deep Creek			
278	W	159	5/17/94	Deep Creek			
279	W	150	5/17/94	Deep Creek			
280	W	153	5/17/94	Deep Creek			
281	W	160	5/17/94	Deep Creek			
282	W	185	5/17/94	Deep Creek			
		124	5/17/94	Deep Creek			
		140	5/17/94	Deep Creek			
		144	5/17/94	Deep Creek			
283	W	162	5/17/94	Deep Creek			
		138	5/17/94	Deep Creek			
		126	5/17/94	Deep Creek			
		104	5/17/94	Deep Creek			
		64	5/17/94	Deep Creek			
		132	5/17/94	Deep Creek			
		138	5/17/94	Deep Creek			
284	W	156	5/17/94	Deep Creek			
285	W	155	5/17/94	Deep Creek			
		130	5/17/94	Deep Creek			
286	W	155	5/17/94	Deep Creek			

Appendix 1. Continued.

Tag Number	Color	Length (mm)	Date Captured	Site Captured	Recapture Date	Recapture Site	Length (mm)
		124	5/17/94	Deep Creek			
		142	5/17/94	Deep Creek			
287	W	152	5/17/94	Deep Creek			
		141	5/17/94	Deep Creek			
		132	5/17/94	Deep Creek			
		125	5/17/94	Deep Creek			
		135	5/17/94	Deep Creek			
		118	5/17/94	Deep Creek			
		120	5/17/94	Deep Creek			
		103	5/17/94	Deep Creek			
7545	OR	222	7/6/95	Deep Creek			
7546	OR	207	7/6/95	Deep Creek			
7547	OR	185	7/6/95	Deep Creek			
7549	OR	205	7/6/95	Deep Creek			
7548	OR	201	7/6/95	Deep Creek			
7550	OR	192	7/6/95	Deep Creek			
7551	OR	178	7/6/95	Deep Creek			
7552	OR	182	7/6/95	Deep Creek			
7553	OR	148	7/6/95	Deep Creek			
		128	7/6/95	Deep Creek			
7554	OR	219	7/6/95	Deep Creek			
7555	OR	195	7/6/95	Deep Creek			
7556	OR	192	7/6/95	Deep Creek			
7558	OR	228	7/6/95	Deep Creek			
7560	OR	226	7/6/95	Deep Creek			
7561	OR	229	7/6/95	Deep Creek			
7562	OR	209	7/6/95	Deep Creek			
7563	OR	212	7/6/95	Deep Creek			
7564	OR	206	7/6/95	Deep Creek			
7565	OR	190	7/6/95	Deep Creek			
7566	OR	155	7/6/95	Deep Creek			
7567	OR	155	7/6/95	Deep Creek			
		126	7/6/95	Deep Creek			
7568	OR	219	7/6/95	Deep Creek			
7569	OR	213	7/6/95	Deep Creek			
7570	OR	212	7/6/95	Deep Creek			
769	Y	235	7/6/95	Deep Creek			
7573	OR	191	7/6/95	Deep Creek			
765	Y	218	7/6/95	Deep Creek			
7574	OR	227	7/6/95	Deep Creek			
7571	OR	184	7/6/95	Deep Creek			
7572	OR	200	7/6/95	Deep Creek			
7557	OR	195	7/6/95	Deep Creek			
7575	OR	223	7/6/95	Deep Creek			
7576	OR	180	7/6/95	Deep Creek			

Appendix 1. Continued.

Tag Number	Color	Length (mm)	Date Captured	Site Captured	Recapture Date	Recapture Site	Length (mm)
7577	OR	158	7/6/95	Deep Creek			
7578	OR	172	7/6/95	Deep Creek			
		126	7/6/95	Deep Creek			
		132	7/6/95	Deep Creek			
		138	7/6/95	Deep Creek			
763	Y	210	7/6/95	Deep Creek			
7579	OR	190	7/6/95	Deep Creek			
7580	OR	195	7/6/95	Deep Creek			
7581	OR	225	7/6/95	Deep Creek			
7582	OR	213	7/6/95	Deep Creek			
7583	OR	214	7/6/95	Deep Creek			
7584	OR	199	7/6/95	Deep Creek			
7585	OR	196	7/6/95	Deep Creek			
764	Y	212	7/6/95	Deep Creek			
7586	OR	205	7/6/95	Deep Creek			
7587	OR	170	7/6/95	Deep Creek			
7588	OR	204	7/6/95	Deep Creek			
7589	OR	208	7/6/95	Deep Creek			
7590	OR	194	7/6/95	Deep Creek			
7591	OR	189	7/6/95	Deep Creek			
7592	OR	198	7/6/95	Deep Creek			
7593	OR	195	7/6/95	Deep Creek			
7594	OR	174	7/6/95	Deep Creek			
7595	OR	170	7/6/95	Deep Creek			
7596	OR	167	7/6/95	Deep Creek			
7597	OR	165	7/6/95	Deep Creek			
7598	OR	192	7/6/95	Deep Creek			
7599	OR	229	7/6/95	Deep Creek			
775	Y	209	7/6/95	Deep Creek			
		137	7/6/95	Deep Creek			
7600	OR	209	7/6/95	Deep Creek			
7601	OR	209	7/6/95	Deep Creek			
7602	OR	198	7/6/95	Deep Creek			
7603	OR	168	7/6/95	Deep Creek			
7604	OR	146	7/6/95	Deep Creek			
7605	OR	166	7/6/95	Deep Creek			
7606	OR	156	7/6/95	Deep Creek			
		130	7/6/95	Deep Creek			
		92	5/20/93	Walnut Creek			
		131	5/20/93	Walnut Creek			
762	Y	207	5/20/93	Walnut Creek			
		132	5/20/93	Walnut Creek			
761	Y	151	5/20/93	Walnut Creek	6/8/93	Walnut Creek	154
		86	5/20/93	Walnut Creek			
		98	5/20/93	Walnut Creek			

Appendix 1. Continued.

Tag Number	Color	Length (mm)	Date Captured	Site Captured	Recapture Date	Recapture Site	Length (mm)
		110	5/20/93	Walnut Creek			
		117	5/20/93	Walnut Creek			
		102	5/20/93	Walnut Creek			
760	Y	174	5/20/93	Walnut Creek			
		135	5/20/93	Walnut Creek			
		92	5/20/93	Walnut Creek			
		127	5/20/93	Walnut Creek			
		119	5/20/93	Walnut Creek			
		134	5/20/93	Walnut Creek			
		149	5/20/93	Walnut Creek			
		117	5/20/93	Walnut Creek			
		137	5/20/93	Walnut Creek			
		139	5/20/93	Walnut Creek			
		98	5/20/93	Walnut Creek			
		93	5/20/93	Walnut Creek			
		102	5/20/93	Walnut Creek			
		101	5/20/93	Walnut Creek			
		112	5/20/93	Walnut Creek			
		108	5/20/93	Walnut Creek			
		57	5/20/93	Walnut Creek			
		108	5/20/93	Walnut Creek			
		103	5/20/93	Walnut Creek			
		133	5/20/93	Walnut Creek			
		135	5/20/93	Walnut Creek			
		132	5/20/93	Walnut Creek			
		95	5/20/93	Walnut Creek			
		135	5/20/93	Walnut Creek			
		129	5/20/93	Walnut Creek			
		118	5/20/93	Walnut Creek			
		130	5/20/93	Walnut Creek			
		130	5/20/93	Walnut Creek			
		118	5/20/93	Walnut Creek			
		114	5/20/93	Walnut Creek			
		116	5/20/93	Walnut Creek			
		96	5/20/93	Walnut Creek			
		90	5/20/93	Walnut Creek			
		134	5/20/93	Walnut Creek			
759	Y	156	5/20/93	Walnut Creek			
		129	5/20/93	Walnut Creek			
		103	5/20/93	Walnut Creek			
758	Y	165	5/20/93	Walnut Creek			
		124	5/20/93	Walnut Creek			
757	Y	170	5/20/93	Walnut Creek			
756	Y	169	5/20/93	Walnut Creek			
755	Y	153	5/20/93	Walnut Creek			
		116	5/20/93	Walnut Creek			

Appendix 1. Continued.

Tag Number	Color	Length (mm)	Date Captured	Site Captured	Recapture Date	Recapture Site	Length (mm)
		147	5/20/93	Walnut Creek			
		129	5/20/93	Walnut Creek			
		105	5/20/93	Walnut Creek			
		108	5/20/93	Walnut Creek			
		115	5/20/93	Walnut Creek			
		110	5/20/93	Walnut Creek			
		110	5/20/93	Walnut Creek			
		136	5/20/93	Walnut Creek			
		107	5/20/93	Walnut Creek			
		124	5/20/93	Walnut Creek			
		144	5/20/93	Walnut Creek			
		109	5/20/93	Walnut Creek			
		116	5/20/93	Walnut Creek			
		100	5/20/93	Walnut Creek			
		147	5/20/93	Walnut Creek			
		131	5/20/93	Walnut Creek			
		145	5/20/93	Walnut Creek			
		140	5/20/93	Walnut Creek			
		140	5/20/93	Walnut Creek			
		116	5/20/93	Walnut Creek			
		120	5/20/93	Walnut Creek			
		140	5/20/93	Walnut Creek			
		98	5/20/93	Walnut Creek			
		137	5/20/93	Walnut Creek			
		140	5/20/93	Walnut Creek			
		142	5/20/93	Walnut Creek			
		136	5/20/93	Walnut Creek			
		128	5/20/93	Walnut Creek			
		117	5/20/93	Walnut Creek			
		101	5/20/93	Walnut Creek			
		131	5/20/93	Walnut Creek			
		154	5/20/93	Walnut Creek			
		98	5/20/93	Walnut Creek			
		100	5/20/93	Walnut Creek			
		104	5/20/93	Walnut Creek			
		105	5/20/93	Walnut Creek			
		82	5/20/93	Walnut Creek			
		123	5/20/93	Walnut Creek			
		139	5/20/93	Walnut Creek			
		117	5/20/93	Walnut Creek			
		135	5/20/93	Walnut Creek			
		94	5/20/93	Walnut Creek			
		149	5/20/93	Walnut Creek			
		102	5/20/93	Walnut Creek			
		131	5/20/93	Walnut Creek			
		137	5/20/93	Walnut Creek			

Appendix 1. Continued.

Tag Number	Color	Length (mm)	Date Captured	Site Captured	Recapture Date	Recapture Site	Length (mm)
754	Y	166	5/20/93	Walnut Creek	6/8/93	Walnut Creek	170
		129	5/20/93	Walnut Creek			
		124	5/20/93	Walnut Creek			
		102	5/20/93	Walnut Creek			
		115	5/20/93	Walnut Creek			
		130	5/20/93	Walnut Creek			
		96	5/20/93	Walnut Creek			
		131	5/20/93	Walnut Creek			
		94	5/20/93	Walnut Creek			
		131	5/20/93	Walnut Creek			
		129	5/20/93	Walnut Creek			
		99	5/20/93	Walnut Creek			
		124	5/20/93	Walnut Creek			
		107	5/20/93	Walnut Creek			
		89	5/20/93	Walnut Creek			
		105	5/20/93	Walnut Creek			
		92	5/20/93	Walnut Creek			
		116	5/20/93	Walnut Creek			
		143	5/20/93	Walnut Creek			
		134	5/20/93	Walnut Creek			
		125	5/20/93	Walnut Creek			
		116	5/20/93	Walnut Creek			
		89	5/20/93	Walnut Creek			
		97	5/20/93	Walnut Creek			
		111	5/20/93	Walnut Creek			
		89	5/20/93	Walnut Creek			
		101	5/20/93	Walnut Creek			
		57	5/20/93	Alder Creek			
		116	5/20/93	Alder Creek			
		146	5/20/93	Alder Creek			
1017	OR	161	5/20/93	Alder Creek	6/9/93	Alder Creek	165
		130	5/20/93	Alder Creek			
1018	OR	185	5/20/93	Alder Creek	6/9/93	Alder Creek	185
		149	5/20/93	Alder Creek			
		130	5/20/93	Alder Creek			
		110	5/20/93	Alder Creek			
		115	5/20/93	Alder Creek			
		99	5/20/93	Alder Creek			
		114	5/20/93	Alder Creek			
		117	5/20/93	Alder Creek			
		114	5/20/93	Alder Creek			
		118	5/20/93	Alder Creek			
		110	5/20/93	Alder Creek			
		120	5/20/93	Alder Creek			
		98	5/20/93	Alder Creek			

Appendix 1. Continued.

Tag Number	Color	Length (mm)	Date Captured	Site Captured	Recapture Date	Recapture Site	Length (mm)
		112	5/20/93	Alder Creek			
		109	5/20/93	Alder Creek			
		122	5/20/93	Alder Creek			
		100	5/20/93	Alder Creek			
		134	5/20/93	Alder Creek			
		105	5/20/93	Alder Creek			
		110	5/20/93	Alder Creek			
1019	OR	239	5/20/93	Alder Creek			
1020	OR	250	5/20/93	Alder Creek			
1021	OR	230	5/20/93	Alder Creek			
1022	OR	258	5/20/93	Alder Creek			
1023	OR	240	5/20/93	Alder Creek			
1024	OR	181	5/20/93	Alder Creek	6/9/93	Alder Creek	177
		140	5/20/93	Alder Creek			
1025	OR	175	5/20/93	Alder Creek			
		121	5/20/93	Alder Creek			
		124	5/20/93	Alder Creek			
1514	OR	161	5/20/93	Alder Creek			
		122	5/20/93	Alder Creek			
		111	5/20/93	Alder Creek			
		124	5/20/93	Alder Creek			
		138	5/20/93	Alder Creek			
		122	5/20/93	Alder Creek			
1515	OR	150	5/20/93	Alder Creek	6/9/93	Alder Creek	146
		113	5/20/93	Alder Creek			
		124	5/20/93	Alder Creek			
		120	5/20/93	Alder Creek			
		96	5/20/93	Alder Creek			
		144	5/20/93	Alder Creek			
		125	5/20/93	Alder Creek			
		126	5/20/93	Alder Creek			
		139	5/20/93	Alder Creek			
		153	5/20/93	Alder Creek			
		145	5/20/93	Alder Creek			
3869	Y	184	5/20/93	Alder Creek	6/9/93	Crane Creek	185
3868	Y	175	5/20/93	Alder Creek			
3866	Y	163	5/20/93	Alder Creek	6/9/93	Crane Creek	158
3865	Y	158	5/20/93	Alder Creek			
3864	Y	165	5/20/93	Alder Creek			
3863	Y	165	5/20/93	Alder Creek			
		145	5/20/93	Alder Creek			
3862	Y	166	5/20/93	Alder Creek			
3861	Y	160	5/20/93	Alder Creek			
		145	5/20/93	Alder Creek			
3860	Y	151	5/20/93	Alder Creek			
		149	5/20/93	Alder Creek			

Appendix 1. Continued.

Tag Number	Color	Length (mm)	Date Captured	Site Captured	Recapture Date	Recapture Site	Length (mm)
3859	Y	151	5/20/93	Alder Creek			
		146	5/20/93	Alder Creek			
		147	5/20/93	Alder Creek			
		149	5/20/93	Alder Creek			
		129	5/20/93	Alder Creek			
		128	5/21/93	Crane Creek			
		121	5/21/93	Crane Creek			
		122	5/21/93	Crane Creek			
		135	5/21/93	Crane Creek			
		149	5/21/93	Crane Creek			
		131	5/21/93	Crane Creek			
		129	5/21/93	Crane Creek			
		146	5/21/93	Crane Creek			
		140	5/21/93	Crane Creek			
		125	5/21/93	Crane Creek			
		112	5/21/93	Crane Creek			
		136	5/21/93	Crane Creek			
		144	5/21/93	Crane Creek			
		125	5/21/93	Crane Creek			
		136	5/21/93	Crane Creek			
		126	5/21/93	Crane Creek			
		149	5/21/93	Crane Creek			
		133	5/21/93	Crane Creek			
		124	5/21/93	Crane Creek			
		151	5/21/93	Crane Creek			
1314	OR	169	5/21/93	Crane Creek			
1315	OR	226	5/21/93	Crane Creek			
		158	5/21/93	Crane Creek			
1316	OR	235	5/21/93	Crane Creek	6/9/93	Crane Creek	234
		156	5/21/93	Crane Creek			
1317	OR	160	5/21/93	Crane Creek			
1318	OR	164	5/21/93	Crane Creek			
1320	OR	197	5/21/93	Crane Creek			
1321	OR	234	5/21/93	Crane Creek			
1322	OR	165	5/21/93	Crane Creek	6/9/93	Crane Creek	170
		151	5/21/93	Crane Creek			
1324	OR	165	5/21/93	Crane Creek			
1325	OR	187	5/21/93	Crane Creek			
3874	Y	166	5/21/93	Crane Creek	6/9/93	Crane Creek	175
3873	Y	175	5/21/93	Crane Creek	6/9/93	Crane Creek	180
3872	Y	161	5/21/93	Crane Creek			
3870	Y	156	5/21/93	Crane Creek			
1523	OR	166	5/21/93	Crane Creek			
		156	5/21/93	Crane Creek			
1520	OR	168	5/21/93	Crane Creek	6/9/93	Crane Creek	166

Appendix 1. Concluded.

Tag Number	Color	Length (mm)	Date Captured	Site Captured	Recapture Date	Recapture Site	Length (mm)
1522	OR	197	5/21/93	Crane Creek			
		145	5/21/93	Crane Creek			
		134	5/21/93	Crane Creek			
		133	5/21/93	Crane Creek			
		135	5/21/93	Crane Creek			
		155	5/21/93	Crane Creek			
1521	OR	166	5/21/93	Crane Creek	6/9/93	Crane Creek	162
		151	5/21/93	Crane Creek			
		140	5/21/93	Crane Creek			
		115	5/21/93	Crane Creek			
		146	5/21/93	Crane Creek			
		111	5/21/93	Crane Creek			
		142	5/21/93	Crane Creek			
		108	5/21/93	Crane Creek			
		124	5/21/93	Crane Creek			
1525	OR	175	5/21/93	Crane Creek			
1524	OR	171	5/21/93	Crane Creek	6/9/93	Moose Creek	166
		139	5/21/93	Crane Creek			
		136	5/21/93	Crane Creek			
		131	5/21/93	Crane Creek			
		147	5/21/93	Crane Creek			
		130	5/21/93	Crane Creek			
		121	5/21/93	Crane Creek			
		129	5/21/93	Crane Creek			
		119	5/21/93	Crane Creek			
		144	5/21/93	Crane Creek			
		127	5/21/93	Crane Creek			
		149	5/21/93	Crane Creek			
		135	5/21/93	Crane Creek			
		119	5/21/93	Crane Creek			
		126	5/21/93	Crane Creek			
		169	5/21/93	Crane Creek			
		152	5/21/93	Crane Creek			
		155	5/21/93	Crane Creek			
1516	OR	190	5/20/93	Moose Creek			
1517	OR	184	5/20/93	Moose Creek	6/9/93	Moose Creek	186
		145	5/20/93	Moose Creek			
1518	OR	156	5/20/93	Moose Creek			
		146	5/20/93	Moose Creek			
1519	OR	161	5/20/93	Moose Creek			